Comments on
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A-Zone Groundwater Recovery System Brown & Bryant Superfund Site Arvin, California
Prepared for: U.S. Army Corps of Engineers
Prepared by: Eco & Associates, Inc. Orange, California 92867
2011"
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Excerpts from Report

"1.3 SCOPE

The history of groundwater well contamination at the Site has been well documented since 1993 when the Site was placed on the National Priorities List. The large diameter well, or arbor well, was selected as a remedy in the OU2 Record of Decision (ROD) as a source of reduction in the A-zone. The OU2 Remedial Investigation/Feasibility Study (RI/FS) and ROD describes these wells as 8-foot diameter wells with an average depth of 75 feet below ground surface (bgs). In past groundwater extraction tests, the A-zone formation has been very tight allowing only an average of 0.25 gallons per minute intermittent extraction. These wells would function as sumps to allow a larger volume of the A-zone groundwater to collect and then be extracted and treated for proper disposal. Ultimately, this would also reduce the amount of A-zone groundwater that would infiltrate to the B-zone, thereby reducing a continuing contamination source to the B-zone."

"3.0 HYDROGEOLOGIC REVIEW OF A-ZONE GROUNDWATER"

May 3, 2010 letter from Jim Van deWater, Consulting Hydrogeologist, Irvine, CA to Mohammad Estiri, Eco & Associates, Orange, CA

Letter Page 1:

"Subject: Hydrogeologic Review for Planned Remediation of A-Zone Groundwater, Brown & Bryant Superfund Site

"*Dear Dr. Estiri:*

As you requested in the meeting held at your office on March 25, 2010[1], I am providing this hydrogeologic review for the Brown & Bryant Superfund Site located in Arvin, California (the Site; ***Figure 1****). As discussed, this review focuses on the planned remediation by means of dewatering the "A-zone". This approach, which can be characterized as an attempt to pump a series of large diameter wells in order to dewater the A-zone, has been selected because the A-zone is of limited extent and contains relatively high concentrations of dissolved agricultural chemicals, most notably the herbicide dinoseb.[2] The intent would be to remove the source of contaminated groundwater that may migrate downward and impact deeper groundwater zones (i.e., the B-zone and C-zone). It is assumed that the source of the groundwater found in the A-zone was the now-capped ponds associated with the former operation at the site. A-zone groundwater is currently monitored by means of 25 monitoring wells as shown in* ***Figure 2****. It is my understanding that the proposed groundwater remediation system has been documented into* *the Record of Decision (ROD) for the Site and is planned to consist of four, large-diameter groundwater extraction wells/sumps (***Attachment A***)[3].”*

Text of letter Pages 3-9:

“1.1 OPERATIONAL HISTORY (USEPA, 2003)[6]

The B&B facility operated as a pesticide reformulator and custom applicator facility from 1960 to 1989. The facility formulated agricultural chemicals, including pesticides, herbicides, fumigants, and fertilizers, for sale to the local farming community between 1960 and 1968. In 1981, the facility was licensed under the Resource and Conservation Recovery Act (RCRA) as a hazardous waste transporter. Contamination of soil and groundwater resulted from inadequate procedural controls, chemical spills during operations, and leaks from a surface wastewater pond and sumps. The largest releases on Site were from the wastewater pond, a sump area, and a dinoseb spill area.

The wastewater pond located in the southwest portion of the Site was originally excavated as an unlined earthen pond in 1960. The pond was used to collect run-off water from the yard and from two sumps (since excavated). The pond was also used to collect rinse water from rinsing tanks used for fumigants. Excess pond water and rain water run-off also collected in a topographically low area to the east and south of the pond. In addition, ponded water from precipitation and irrigation from the east has occasionally breached the berm in the southeast corner of the pond and drained into the pond. The pond was double lined with a synthetic liner in November 1979. The liner and additional soil were excavated in August 1987. Approximately 640 cubic yards of soil that showed visible signs of contamination were removed from the pond at that time. The depths of this excavation ranged from approximately one and one-half feet on the sides to five feet on the bottom.

In 1960, an unlined earthen sump was constructed in the center of the Site. The sump was used to collect wash water from a pad where equipment and tanks used for liquid fertilizers and fumigants were washed. Water from the sump was drained to the pond through an underground pipeline. In 1980, the sump was replaced with two double lined sumps, and two lined sand traps were installed west of the pond. Dinoseb was stored in a smaller tank storage area along the eastern fence, just north of the pond. In 1983, there was a significant dinoseb spill in this area. As a result, the soil and groundwater underlying this portion of the Site has been reported with the highest concentrations of dinoseb. The USEPA excavated highly contaminated soil from this area in the mid 1990s.

1.2 ENVIRONMENTAL HISTORY

In 1989, the Site was listed on the National Priorities List (NPL). In the same year, all operations at the Site ceased. Subsequently, various emergency and removal actions were initiated to minimize or eliminate immediate threats to human health and the environment. A review of the available reports, generated between 1987 through 2006, indicates that the Site has been the subject of several investigations to assess the nature and extent of contamination. Based on the available documents, the Site investigations were conducted under two separate operable units: OU-1 and OU-2.

1.2.1 OU-1

The study area for the OU-1 investigations included surface soil, the unsaturated A-zone, and the A-zone groundwater. The A-zone includes unsaturated soils below ground surface (bgs), which may vary in thickness from 65 to 85 feet, and the first water-bearing unit, the A-zone groundwater. The depth to the saturated zone generally varies between 65 and 75 feet bgs. The base of the A-zone is a thin sandy clay layer between 75 and 85 feet bgs. The A-zone groundwater occurs beneath the entire Site but pinches out between 500 and 600 feet south of the Site, 200 feet east of the Site, and 300 feet west of the Site.

1.2.2 OU-2

The study area for the OU-2 investigation includes the unsaturated zone beneath the A-zone aquifer and the B-zone aquifer. The B-zone includes unsaturated soil beneath the A-zone and the second lowest water-bearing unit (B-zone groundwater) at 140 to 165 feet bgs. The B-zone extends to at least 250 feet bgs and ends at a clay layer (known as the Corcoran Clay) that confines the drinking water aquifer (the C-zone) beneath it. The Corcoran Clay, also locally known as the "Blue Clay" or the "E-Clay" is a member of the Tulare Formation and is the predominant aquitard separating the semi-confined water-bearing layers above it and the confined aquifer beneath. It is a regionally extensive lacustrine deposit of low permeability (Johnson et al., 1968)[7] ranging in thickness from 20 feet to over 100 feet. Based on the driller's log for Arvin City Well No. 1, it is estimated that the Corcoran Clay layer in the area of the Site is at least 27 feet thick.

1.3 SITE GEOLOGY AND HYDROGEOLOGY

The Site is underlain with an alluvial deposit of alternating layers and mixtures of unconsolidated sands, silts, and clay. Soil underlying the Site to a depth of 80 feet generally consists of silty fine sand to fine sandy silt. Clean, well-graded sand lenses and seams of silty clay occur locally within these soils. The soils are generally thinly interbedded, with textural changes occurring every few vertical inches. These textural changes are also believed to occur laterally.

The Site geology has been divided into two zones: the A-zone and the B-zone. The characteristics of these two zones are summarized below.

1.3.1 A-Zone

The A-zone includes unsaturated soil at 65 to 75 feet bgs and includes the first water bearing unit, the A-zone groundwater. The depth to the saturated zone varied between 65 and 85 feet bgs in April 2008 and between 69 and 87 feet bgs in April 2009. In April 2008, 9 of the 25 A-zone wells were reported to be dry (Table 1 of E&A, 2008); in April 2009, 10 of the 25 A-zone wells were reported to be dry (Table 1 of E&A, 2009). The base of the A-zone is a thin sandy clay layer between 75 and 85 feet bgs. The clay layer and the A-zone groundwater extends beneath the entire Site but its off-site extent is limited to an area extending 640 feet south, 560 feet east, and 500 feet west of the Site.[8] The clay layer and A-zone groundwater are reportedly absent beyond these distances from the Site.

Groundwater in the A-zone flows is reported to flow in a generally southern direction with some mounding of the water table observed extending southward from the southwest corner of the Site.[9]
The saturated thickness of the A-zone groundwater ranges from 0 to 10 feet. The groundwater velocity in the A-zone has been estimated at 53 feet per year. Slug test results suggest that a yield of less than 100 gallons per day can be expected for wells in the A-zone. Aquifer testing of three of the on-site extraction wells showed a groundwater yield of approximately ¼ gallon per minute (gpm).

1.3.2 B-Zone

The B-zone includes unsaturated soil beneath the A-zone and the second lowest water-bearing unit (B-zone groundwater) at 140 to 165 feet bgs. The B-zone extends to at least 250 feet bgs and ends at a clay layer known as the Corcoran Clay that confines the drinking water aquifer beneath it. The thickness of this clay layer beneath the Site is unknown.

The B-zone groundwater comprises a series of water-bearing units. Wells in the B-zone were installed in the water-bearing units located at approximately 145 feet bgs and 170 feet bgs. The direction of flow in the water-bearing unit at 170 feet bgs is to the south, and the gradient is 0.0004 feet per foot. Permeabilities are much higher than for the A-zone. Past pump tests for the water-bearing unit at 170 feet bgs indicated that wells could be pumped at 7 gpm for an extended period.

1.3.3 Groundwater Monitoring Well Network

The groundwater monitoring well network is shown in ***Figure 2****. It consists of 44 groundwater monitoring wells[10]. Twenty-five of these wells are screened within the A-zone aquifer; the remaining 19 wells are screened in the B-zone aquifer.*

1.3.4 A-Zone and B-Zone Groundwater Contamination

Subsurface investigations conducted on Site to date have confirmed the presence of a number of potentially hazardous substances in the groundwater. In general, the A-zone groundwater contains more analytes and at higher concentrations than the B-zone groundwater. The primary chemicals of concern (COCs) in groundwater include:

- *Chloroform;*
- *1,2-Dibromo-3-chloropropane (DBCP);*
- *1,2-Dichloropropane (1,2-DCP);*
- *1,3-Dichloropropane (1,3-DCP);*
- *1,2,3-Trichloropropane (1,2,3-TCP);*
- *Ethylene dibromide (EDB); and*
- *Dinoseb.*

Dinoseb has been detected at concentrations above 1,000,000 micrograms per liter (ug/L) in groundwater samples collected from monitoring wells completed in the A-zone. Dinoseb is a contact herbicide commonly used for post-emergence weed control in a variety of crops. The maximum contaminant level (MCL) for dinoseb in drinking water is 7 ug/L."

The contamination in the perched aquifer poses a potential threat to the underlying unconfined regional aquifer (B-zone) and the C-zone aquifer that is used for municipal drinking water.

Public and private wells within 3 miles of the Site provide drinking water to 7,200 people and irrigate 19,600 acres of cropland. City of Arvin Well #1 (CW-1) is located approximately 1,500 feet from the Site (USEPA, 1993)[11]. This well is currently out of operation."

2 REVIEW OF HYDROGEOLOGIC DATA

*There are two areas of low groundwater elevations ('sinks') depicted on **Figure 3** (E&A, 2008); these sinks are also present on Figure 3 of E&A (2009)[12] and Figure I-11 of Panacea (2004). Groundwater is depicted as flowing into these sinks on these figures. One sink is located southwest of the Site in the vicinity of A-zone monitoring wells EPAS-1 and PWA-4 and the other is located southeast of the Site near A-zone monitoring well PWA-2. Using the groundwater elevation contours in **Figure 3**, the southwest sink is characterized as a roughly 100 x 200 foot area. Using the groundwater elevation contours in **Figure 3**, the southeast sink appears to be centered on PWA-2 but its extent is not discernible. In general, the highest concentrations of dissolved contaminants in A-zone groundwater are now found in the vicinity of these sinks, particularly the southeast sink.[13] Possible explanations for any groundwater sink include but are not limited to:*

- *operation of one or more extraction wells,*
- *the presence of a natural breach (absence or increased sand content) of the underlying sandy clay aquitard.*

Based on information provided by E&A's client, no extraction wells currently operating. The presence of a breach is plausible given that the aquitard (a) is known to be generally limited in lateral extent and (b) contains sand.

The exact nature and extent(s) of the aquitard breach(es) that are assumed to create the sinks is unknown but may be interpreted as creating a "zone of capture" into which impacted groundwater may be flowing. There is insufficient data available to estimate the zone of capture for the proposed large diameter groundwater recovery wells given the limited information provided by the slug and aquifer test data, the irregular hydraulic gradient, and – most importantly - the limited information regarding the presence and nature of the sinks southwest and southeast of the Site. It is important to keep in mind that the ultimate goal is dewatering of the A-zone; therefore, A-zone groundwater elevations – not the capture zone - is of primary importance. However, it may be assumed that the installation and testing of a large diameter extraction well would provide approximately ¼-gallon per minute (gpm) reported from aquifer testing of three of the on-site extraction wells. Even if testing of the large diameter extraction wells does not indicate a zone of capture that extends entirely under the capped area, it is expected that such wells may be beneficial in reducing the flow of impacted groundwater into sinks where it may impact deeper zones.

3 RECOMMENDED APPROACH FOR DESIGN OF GROUNDWATER DEWATERING WELLFIELD

Two recommended approaches are outlined below. The first assumes that no additional data can be collected (i.e., the wellfield is to be designed based solely on the existing data); the second assumes that additional data can be collected.

3.1 IF NO ADDITIONAL DATA CAN BE COLLECTED

As stated above in the introductory paragraph of this report, it is my understanding that the proposed groundwater remediation system has been documented into the ROD for the Site and is planned to consist of four, large-diameter groundwater extraction wells/sumps. If no additional data are to be collected (i.e., the wellfield is to be designed based solely on the existing data), it is recommended that two wells be installed in the southeast sink area and the other two wells be installed in the southwest sink area. The sink areas are recommended locations because:

- *the sinks generally contain the highest contaminant concentrations in A-zone groundwater,*
- *A-zone groundwater and any dissolved contaminants therein will flow naturally toward the wells regardless of whether they are pumping or not, and*
- *extraction wells located in the sinks should have a reasonable chance of being continuously 'pumpable' compared to other areas of the Site.*

The screened interval of the wells should extend to the top of the aquitard separating the A-zone from the B-zone (approximately 85 feet bgs) with a sediment trap/sump and pump set a foot or two below the top of the aquitard (as shown in ***Attachment A****) with caution taken to ensure the well is not screened and/or gravel packed across the aquitard in such a way as to inadvertently provide a conduit for contaminants to migrate downward from the A-zone into the B-zone and deeper zones.[14] Based on information provided by E&A's client, the wells will not be pumped continuously because there are no plans to plumb them to a continuously-operating treatment and discharge system. Given the propensity for wells to go dry in the A-zone, it is recommended that the wells be equipped with a water level sensor so that the pump shuts off when the well goes dry.*

3.2 IF ADDITIONAL DATA CAN BE COLLECTED

As stated above in Section 2, the nature of the sinks which appear to govern groundwater flow in the A-zone is unknown. Given this uncertainty, it is recommended that additional data be collected prior to installing any dewatering wells. In order to obtain the data needed to evaluate the parameters involved in designing and fully implementing a dewatering program for the A-zone it is expected that a single test well would need to be installed and operated for some extended period of time. As above, the initial large diameter extraction well should be constructed in such a way as to fully access the A-zone and not inadvertently breach the aquitard and thus inadvertently provide a potential pathway for contaminants to migrate to deeper groundwater zones.

The two data collection tasks outlined below (i.e., Task 1 and Task 2) are recommended to assist in the final design of the groundwater dewatering wellfield. Given the anticipated low and intermittent pumping rates, minimal saturated thickness of the A-zone[15], and the objective of the remedial effort (i.e., dewatering the A-zone), groundwater modeling (e.g., using a numerical flow/capture zone model such as MODFLOW/MODPATH) is not included among these two tasks. If delineation of a capture zone is deemed necessary, it is anticipated that the best way to do so would be direct measurement of groundwater elevations (as opposed to modeling). If groundwater modeling is deemed necessary, it is expected that the usefulness of any such model would hinge on a thorough understanding of the nature of the sinks and the aquitard separating the A-zone from the B-zone.

3.2.1 Task 1 – Identify Location for Test Well and Monitoring Wells

It is recommended that cone penetrometer testing (CPT) be conducted in and around the sink areas to better understand the nature and extent of the A-zone and underlying aquitard to identify an appropriate location, total depth, and screened interval[16] for the test well and additional A-zone groundwater monitoring wells. Specifically, groundwater extraction may be most sustainable if the extraction well(s) are located in depressions in the upper surface of the aquitard and/or areas consisting of comparatively coarser-grained soils. Since the objective is to dewater the A-zone, the additional A-zone monitoring wells will be needed to assess the degree to which the objective is ultimately met. The additional monitoring wells should be minimum 2-inch diameter PVC – and ideally, 4-inch PVC[17] - and extend to the top of the aquitard separating the A-zone from the B-zone.

3.2.2 Task 2 – Step-Drawdown Testing

Following development of the test well and additional monitoring wells, the maximum sustainable pumping rate should be established by sequentially increasing the pumping rate through a "step-drawdown" test. It is recommended that the step-drawdown test consist of a minimum of three to four 1- to 2-hour "steps" (i.e., pumping rates). For example, the steps could be attempted as follows:

- *Step 1: Pump test well at constant rate of 0.1 gpm for 2 hours;*
- *Step 2: Pump test well at constant rate of 0.25 gpm for 2 hours;*
- *Step 3: Pump test well at constant rate of 0.5 gpm for 2 hours.*

It is recognized that (a) these pumping rates and durations may not be achievable and (b) maintaining a "constant" pumping rate at such low levels may prove difficult and that the well may pump dry fairly quickly despite data collected as part of Task 1.[18] The step-drawdown test would provide the sustainable pumping rate for longer term testing/pumping. Analysis of the step-drawdown test data may also allow for an estimation of well efficiency and hydraulic conductivity.

CLOSING

Thank you for providing me the opportunity to provide consulting services to E&A. If you have any questions, please contact me at (949) 795-0855 or jimvdw@cox.net.
Sincerely,
Jim Van de Water, CHG
Consulting Hydrogeologist"

Footnotes in quoted text:

[1] *Attendees at this meeting included Mohammad Estiri (Eco & Associates, Inc.), Jim Van de Water (Consulting Hydrogeologist), and David M. Henry, PG (Lexington Geoscience).*

[2] *This review is not a critique of the work done to date and assumes that the documents provided accurately reflect conditions at the Site.*

[3] *Eco & Associates, 2010. Value Engineering Recommendation #40. January 12-13.*

[6] *USEPA (Region IX), 1993. Remedial Investigation/Feasibility Study Report, Brown & Bryant Superfund Site, Arvin, California. May 28th.*

[7] *Johnson, A.I., R.P. Moston, and D.A. Davis, 1968. Physical and Hydrologic Properties of Water-Bearing Materials in Subsiding Areas in Central California. U.S. Geol. Surv. Prof. Paper.*

[8] *The approximate limits of the A-zone Aquifer are shown in Figure I-7 of Panacea (2004).*

[9] *No clearly-defined groundwater flow direction in the A-zone could be determined during this review of available documents. This review also suggests the presence of two sinks (as opposed to mounds) southwest and southeast of the Site. These sinks are described in further detail in Section 2 below.*

[10] *E&A 2008 and 2009 also refers to "… 9 unused groundwater extraction wells…" as being part of the Site well network. These reports also refer to City Well CW-1, which is not sampled as it does not contain a pump."*

[11] *USEPA (Region IX), 1993. Remedial Investigation/Feasibility Study Report, Brown & Bryant Superfund Site, Arvin, California. May 28th.*

[12] *Due to the generally irregular groundwater gradient and presence of these sinks, a capture zone analysis was deemed intractable. The magnitude of the A-zone groundwater gradient is not quantified in E&A 2008 and 2009, presumably due to its irregular nature.*

[13] *The highest A-zone dinoseb concentration in April 2009 was reported in the southeast sink area.*

[14] *It is recommended that the boreholes be continuously cored over their entire length or, at a minimum, between approximately 60 feet bgs and the bottom of the borehole.*

[15] *Groundwater flow models generally work best when there is a reasonably large quantity of groundwater flowing through reasonably homogeneous and permeable materials.*

[16] *Water-bearing A-zone soils generally consist of silty fine sand to fine sandy silt with clean, well-graded sand lenses and seams of silty clay occurring locally. Given the generally fine-grained nature of these soils, it is recommended that a sieve analysis be performed to properly select the screen slot size and gravel pack. Proper slot size and filter pack selection should increase the likelihood that the well will perform its intended function and reduce the potential for clogging of the well screen.*

[17] *If necessary, the monitoring wells could be used (a) to empirically define the capture zone(s) and (b) as dewatering wells in the latter stages of remediation.*

[18] *Because it is anticipated that the wells will run dry fairly quickly, a constant rate / recovery test will not be attempted at this time. If the wells can be pumped continuously at some point, a constant rate recovery test may be considered.*

Overall the proposed approach for enhanced removal of pollutants from the A zone to reduce the ongoing pollution of the B zone appears reasonable.